OPTIMAL ESTIMATION OF RAIN RATE PROFILES FROM SINGLE-FREQUENCY RADAR ECHOES

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The *significant* ambiguities inherent in the determination of a particular vertical rain intensity profile from a given time profile of radar echo powers measured by a downward looking (spaceborne or airborne) radar at a single attenuating frequency are }$'cll-(lot.~]]]-]c]ltcd. Indeed, one already knows that by appropriately varying the parameters of the reflectivity- rai]l-rate (Z - R) and/or attenuation raill-rate (k - R) relationships, one can produce several substantially different rain rate profiles which would produce the same radar power profile. Imposing the additional constraint that the path averaged rain- rate be a given fixed number dots reduce the ambiguities but falls far short of eliminating them. While we have derived the formulas to generate all mutually ambiguous raill-rate profiles from a given profile of rec. eived radar reflectiv ities, there remains to produce a quantitative measure to assess how likely each of t hese profiles is, what the appropriate "average" profile should be, and what the "variance" of these multiple solutions is. Of course, in order to do this, one needs to spell out the stochast ic cons traints that can allow us to make sense of the words "average" and "variance" in a mathematically rigorous way. Such a quantitative approach would be particularly well-suited for such systems as the spaceborne Ku- band Precipitation Radar of the Tropical Rainfall Measuring Mission (TRMM). Indeed, one would then be able to use the radar reflectivities measured by the TRMM radar to estimate the rai]]-rate profile that would most likely have produced the measurements, as well as the uncertainty in the estimated raill-rates as a function of range. We present an optimal non-linear- Kalman-fil tering approach to solve this problem.